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RECONSTRUCTION OF GREEK FISHERY CATCHES BY FISHING GEAR AND AREA (1950-2010)

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ABSTRACT

In the present study, Greek marine fisheries catches by gear and area were reconstructed for the period 1950-2010. The reconstruction incorporated the marine fisheries catches from: (a) professional motor-vessels, (b) professional rowing vessels, (c) recreational motor-vessels, (d) subsistence and recreational angling, (e) discard estimates derived from all professional fisheries and (f) overseas distant-water fisheries. Among the different fisheries components that are presented herein, subsistence and recreational fisheries have never been accounted for Greek waters before. Results indicate that total reconstructed catches (including discarded catches) within Greek waters accounted for over 9.8 million t for the 1950-2010 time period, which is 57% higher than the 6.2 million t officially reported by Greece for their waters. Greek distant-water catches accounted for over 831,000 t, increasing from just over 150 t·year⁻¹ in 1952 to 42,300 t·year⁻¹ in 1971, before declining substantially to 1,300 t·year⁻¹ by 2010. The results showed that the reconstructed marine catches substantially increased from 1950 to the mid 1990s and then declined for the remaining years. This general pattern can be attributed to: (a) the organization of the Greek fisheries administration since the end of WWII; (b) the establishment of fisheries and oceanographic research; (c) the international (up to the mid-1960s) and European (since 1983) funding of the fishing sector; (d) the first restriction on recreational fisheries through national legislation since 1985; and (e) the international agreements and oil crisis events that influenced distant-water fisheries activities. The reconstruction of the Greek fisheries catches by incorporating both the reported and unreported catches will reduce the uncertainty in the evaluation of the Greek fisheries status and will lead to a more realistic assessment of the Greek fisheries.

INTRODUCTION

Official fisheries landings data have often limited accuracy (Pauly and Froese 2012), and false statistics may systematically distort world landing trends, whether over-reported (Watson and Pauly 2001) or underreported (Pauly and Maclean 2003). These data may also lead to an underestimation of the total catch, because they do not include discarded, subsistence, recreational and non-reported catches. All of these components are referred to as illegal, unreported and unregulated catches (IUU). The proper and regular estimation of IUU is a primary target of the European Union policy (Anon. 2011).

In this context, significant attention should be given to data-poor areas such as the Greek waters (Pilling *et al.* 2008), where the multi-species and multi-gear nature of fisheries present certain difficulties for monitoring, especially for the small-scale component (Tzanatos *et al.* 2007). These problems call for a reconstruction of historic fisheries catches (*sensu* Zeller *et al.* 2007), thereby shifting the baseline of Greek fisheries (Pauly 1995) back to its early stage using “pieces of information” (Zeller and Pauly 2006).

Greek commercial fisheries consist of three major sectors: (a) overseas (distant-water); (b) large-scale (or ‘industrial’); and (c) small-scale coastal fisheries (or ‘artisanal’). Category (a) includes large vessels fishing outside Greek Economic Exclusive Zone equivalent waters (i.e., in the Atlantic and along North African Mediterranean coasts; Figure 1), and quantities caught are reported as ‘frozen’. Category (b) includes trawlers, purse seiners and mixed vessels (i.e., those licensed to operate both as trawler and purse-seiner) up to 2005, after which each vessel had to be licensed for a specific gear. Category (c) includes beach-seiners, the operation of which will be banned in 2013 (European Regulation, ER 1967/2006), and other small-scale vessels, using mostly (95%) nets and bottom longlines and operating in coastal Greek waters (Figure 2).

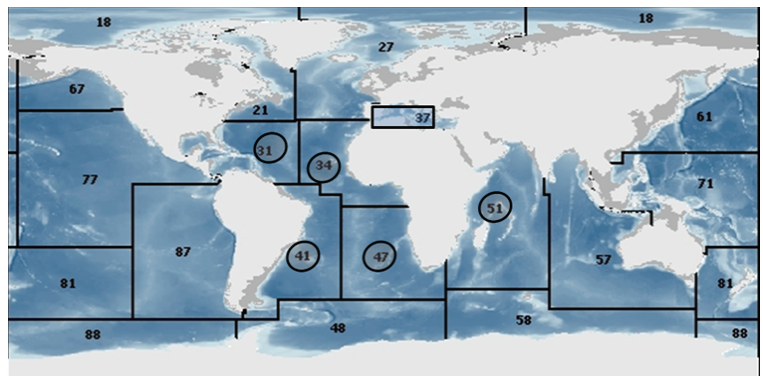


Figure 1. Map of world seas showing the distribution of the Greek overseas fisheries defined in HELSTAT and coded as subareas S1 (FAO areas marked by circles) and S2 (FAO areas marked by square).

The history of Greek fisheries, the administrative organization of fisheries, the methodology of sampling and the reconstruction of Greek commercial fisheries landings during 1928-2007 have been presented in Tsikliras *et al.* (2007) and Moutopoulos and Stergiou (2011, 2012). These studies did not include the landings from Greek distant-water fisheries, recreational fisheries, subsistence fisheries, nor discards. In the present study, we present time series of catches for these four fisheries components for 1950-2010. These catch components are added to the total Greek landings presented in Moutopoulos and Stergiou (2012), and the latter being updated to 2010.

MATERIALS AND METHODS

Update of the reconstructed landings from motorized fishing vessels for 2008-2010

The time series of reconstructed landings by species (i.e., 75 species or groups of species, henceforth called 'species'), subarea (16 subareas; Figure 2) and gear (i.e., trawl, purse-seine, beach-seine and small-scale vessel) during 1928-2007 were updated to 2010 using the data derived from (Table 1): (a) Hellenic Statistical Authority (HELSTAT; previously National Statistical Service of Greece) for all motorized fishing vessels, apart from those with engine power 19 HP (data provided to us by Mrs Elizabeth Vrontou, HELSTAT); (b) Agricultural Statistic of Greece (ASG) for small-scale vessels with engine 19 HP; and (c) Food and Agriculture Organization (FAO) for landings of certain large pelagic species (i.e., *Auxis thazard*, *Euthynnus alletteratus*, *Thunnus spp.* and *Xiphias gladius*).

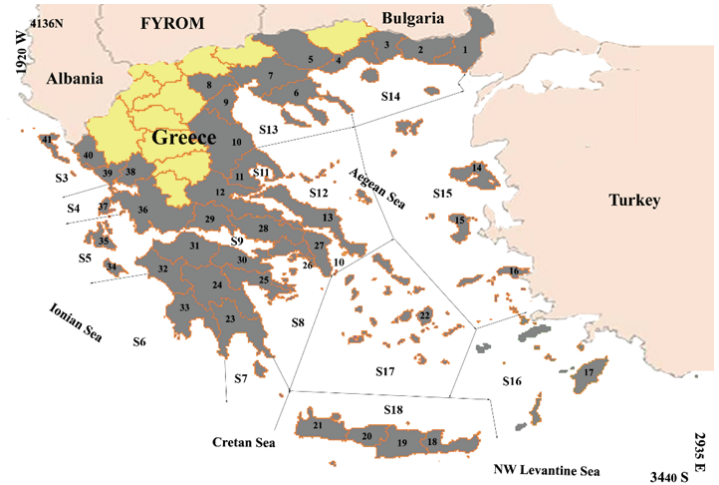


Figure 2. Map of Greek waters showing the division of the fishing subareas allocated by the different fisheries statistical organizations; legends S3 to S18 indicate the 16 fishing subareas (each enclosed by lines) assigned by the Hellenic Statistical Authority of Greece (HELSTAT) for the collection of fisheries statistics for commercial fishing vessels with engine power ≥ 19 HP during 1964-2007; and grey areas indicate the prefectures involved in the collection of fisheries statistics from recreational vessels and commercial vessels with engine power < 19 HP during 1975-2007 reported by Agricultural Statistics of Greece and by Anagnopoulos *et al.* (1998). HELSTAT subareas S1 and S2 are outside Greek waters (see Fig.1; Atlantic Ocean and North African Mediterranean coasts, respectively).

Table 1. Summary of the fisheries landing statistics recorded by the different statistical organizations for Greek waters, 1950-2010.

Period	Fishery type	Species resolution	Gear type	Spatial resolution	Source
1950-2007	Marine	58 fish, 5 cephalopods and 6 crustaceans	Per gear type (i.e. trawl, purse-seine, beach-seine and other small-scale) for all engine vessels	For 16 fishing subareas	Moutopoulos and Stergiou (2012)
1950-1963	All fisheries (i.e., marine*, freshwater and lagoons) combined	Total landings (i.e., all species combined)	All gear types combined for all fishing vessels	Total for Greek waters	Ananiadis (1968)
1975-2007	Marine	Total (i.e. for all fish, cephalopod, and crustacean) annual landings per vessel	Rowing recreational vessels	For 41 prefectures	ASG
1995-1996	Marine	26 fish and 1 cephalopod	Rowing recreational vessels	Total for Greek waters	Anagnopoulos <i>et al.</i> (1998)
2008-2010	Marine	<i>Auxis thazard</i> , <i>Euthynnus alletteratus</i> , <i>Thunnus spp.</i> and <i>Xiphias gladius</i>	All gear types combined excluding small vessels	Total for Greek waters	FAO
2008-2010	Marine	56 fish, 5 cephalopods and 5 crustaceans	Per gear type (i.e. trawl, purse-seine, beach-seine and other small-scale) excluding small vessels	For 16 fishing subareas	HELSTAT
1952-1963	Overseas fisheries	16 fish and 3 cephalopod species	Trawl type	Total for world seas	Ananiadis and Chondronikolas (1970)
1964-1981	Overseas fisheries	17 fish, 4 cephalopods and 1 crustacean	Trawl type	For 22 areas	HELSTAT
1982-2010	Overseas fisheries	56 fish, 5 cephalopods and 5 crustaceans	Trawl type	For 22 areas	HELSTAT

*Bivalve and eel species were excluded from the reconstruction of the fisheries landings from both Greek and overseas landings.

*Boat-based recreational catches*Sources of data

Two agencies are engaged in collecting data for boat-based recreational fisheries (Table 1). HELSTAT, in the framework of the Annual Agricultural Livestock Survey (Agricultural Statistics of Greece-ASG, 1977-2009), routinely collected for each prefecture (Figure 2) between 1975-2005 the number of recreational fishers, the number of recreational vessels and the total landings for all species combined. The data are published in yearly bulletins by ASG (Anon. 1977-2009). We note that because in the 1970s, when ASG started recording data from recreational fisheries, the majority of recreational fishers used rowing vessels or vessels equipped with outboard engines, ASG records still refer to rowing vessels. Yet, nowadays, the majority of the recreational vessels are equipped with inboard engines.

The second agency involved in the collection of data for boat-based recreational fisheries is the Ministry of Mercantile Marine that manages port authorities and records each fisher that owns a recreational license. These data were available only for the period 1995-1996 through a field study conducted on Greek recreational fishery (Anagnopoulos *et al.* 1998).

Reconstruction of boat-based recreational catches

The representative time series for the reconstruction of the vessel-based recreational landings are those derived from the Ministry of Mercantile Marine, which records all the boat-based recreational licenses

To estimate the boat-based recreational landings for 1950-2010, the number of fishers owning a boat-based recreational license was estimated. This was based on the ratio estimated from the number of fishers owning a boat-based recreational license from the Ministry of Mercantile Marine data to the corresponding data derived from ASG records for the years 1994 and 1995. This ratio was used to estimate the number of boat-based recreational fishers during 1975-1993 and 1996-2005 based on the number of recreational fishers reported by ASG.

The boat-based recreational catches were then calculated using the mean catch per fisher of 0.194 t·fisher⁻¹ estimated from Anagnopoulos *et al.* (1998) for the years 1994-1995. This rate was applied to the reconstructed number of boat-based recreational fishers to derive a time series of recreational catches during 1975-2005. Subsequently, this series was expanded to 2010 by fitting a linear trend to the 1995-2005 data. Likewise, for years prior to census data (i.e., 1950-1974), the boat-based recreational landings were linearly interpolated using an exponential trend fitted to the 1975-1985 data for the number of boat-based recreational fishers, as estimated previously, using also, as an anchor point, a study by Anon. (1977) in which recreational catches ranged between 6,000 and 9,000 t in 1970 (we used the maximum value).

Spatial and taxonomic disaggregation of boat-based recreational catches

The spatial allocation of boat-based recreational catches was done using Table 2: (a) the spatial allocation of recreational catches by prefecture as reported by ASG, for the reconstruction of recreational landings during 1950-1993; and (b) the

Table 2. Number of fishers, vessels and engine power per prefecture for recreational fisheries in Greek waters during 1995-1996, based on various sources (described in Materials and Methods).

Prefectures	HELSTAT subareas	HELSTAT		Anagnopoulos <i>et al.</i> (1998)		
		Fishers	Vessels	Fishers	Vessels	HP
Achaia	S5	849	685	2,241	1,654	29,881
Argolida	S8	391	375	1,789	1,011	20,468
Arkadia	S8	52	52	320	289	3,445
Arta	S4	30	30	83	70	-
Chalkidiki	S13	464	249	2,525	1,285	20,540
Chania	S18	262	201	1,849	1,144	22,930
Chios	S15	476	377	771	664	7,727
Dodekanissos	S16	-	-	3,466	2,320	53,516
Etolia and Akarnania	S5	214	210	935	777	12,841
Evia	S10	654	534	1,783	2,635	25,021
Evia	S12	654	534	1,783	2,635	25,021
Evros	S14	69	58	489	486	11,262
Fokida	S9	785	845	658	411	6,593
Fthiotida	S10	459	444	3,519	1,818	33,024
Illia	S6	156	136	918	432	9,510
Iraklio	S18	1,066	231	1,645	1,009	28,761
Kavala	S14	2,805	703	3,271	1,678	66,213
Kefallinia	S5	597	507	1,479	910	12,658
Kerkyra	S3	1,017	361	935	1,522	21,377
Korinthia	S9	1,513	1,339	4,134	2,241	31,022
Kyklades	S17	98	96	5,278	5,544	45,629
Lakonia	S7	346	360	1,573	722	10,625
Larissa	S13	28	21	667	218	3,426
Lassithi	S18	115	93	1,290	709	17,142
Lefkada	S4	133	112	282	268	5,245
Lesvos	S15	454	393	2,893	1,751	27,751
Magnissia	S11	356	275	5,551	3,642	78,450
Messinia	S6	202	153	3,342	1,063	24,690
Pieria	S13	203	190	1,943	1,011	16,938
Preveza	S4	142	122	286	584	13,271
Rethymno	S18	131	126	285	128	2,954
Rodopi	S14	2	2	387	211	4,221
Samos	S15	448	423	298	295	3,410
Thessalaniki	S13	285	210	7,606	5,280	138,277
Thesprotia	S3	57	58	333	250	5,678
Viotia	S9	379	379	472	308	9,469
Xanthi	S14	29	25	767	1,585	39,420
Zakynthos	S5	838	484	471	336	11,188
Greater Athens	S10	2,164	1,332	27,841	22,319	555,144
Total	-	18,923	12,725	96,158	71,214	1,454,738

spatial resolution reported in Anagnopoulos *et al.* (1998), for the reconstruction of recreational catches during 1994-2010. To harmonize the spatial allocation of recreational catches per prefecture during 1950-2010 with the reconstructed catches from all motorized, commercial fishing vessels for the 16 subareas surveyed by HELSTAT (Figure 2) during 1950-2010, as described in above, we re-allocated the recreational catches based on the ratios per HELSTAT subarea shown in Table 3 and the method presented in Moutopoulos and Stergiou (2012).

The taxonomic disaggregation of the boat-based recreational catches during 1950-2010 was done by using the species composition reported in Anagnopoulos *et al.* (1998) (shown in Table 4).

Shore-based subsistence and recreational catches

Sources of data

Shore-based subsistence and recreational angling in Greece are not easily disaggregated into distinct categories as there is obvious overlap (Anon. 2010; Ünal *et al.* 2010). Here, the catches of shore-based subsistence and recreational angling per subarea were estimated for 1950-2010 based on interviews conducted in three major coastal areas, which were subsequently extrapolated to the entire country.

Reconstruction of shore-based subsistence and recreational catches

Three coastal areas from different parts of Greece (Northern Aegean Sea: Kavala Gulf; Central Aegean Sea: Pagasitikos Gulf; and Ionian Sea: Patraikos Gulf) were surveyed based on personal interviews and local recording from 406 recreational fishers in 2012 (Kavala and Pagasitikos Gulfs) and during 2008-2009 (Patraikos Gulf).

Interviews were conducted through personal questionnaires in which fishers were asked to state their: (a) demographic aspects (i.e., age, sex, marital status, education degree, professional occupation); (b) fishing strategy (i.e., frequency of fishing per year, daily fishing hours, species caught, annual catch in weight); and (c) fishing-related expenditures (i.e., transportation, bait, equipment and other costs).

The mean number of fishing days per year ranged from 180 to 193 days-year⁻¹ and the average daily catch ranged between 0.711 and 0.861 kg-fisher⁻¹.day⁻¹ (Table 5). The most representative species (those making up more than 48% of the total catch) for the three studied areas were *Sparus aurata*, Mugilidae and *Diplodus* spp. (Table 5). The yearly catch per fisher for each area was estimated by multiplying the mean number of fishing days with the daily catch per fisher.

To estimate the number of shore-based subsistence and recreational fishers, the resident population of each subarea was used, derived from the census of HELSTAT conducted in each prefecture every decade (www.statistics.gr) between 1950-2010 (Anon. 1955-2012) (see Appendix Table A1). This was multiplied by the ratio of shore-based angler to coastal population in each subarea. The latter was conservatively assumed to be 1.5%, because this ratio lies within the values estimated by other studies conducted for subsistence fisheries in the Eastern Mediterranean Seas (ranging between 1% and 3.3% in Turkish waters, Ünal *et al.* 2010; Ünal and Franquesa 2010).

Spatial and taxonomic disaggregation of shore-based subsistence and recreational catches

To harmonize the spatial allocation of shore-based subsistence and recreational catches per prefecture with the 16 subareas surveyed by HELSTAT (Figure 2), we followed the method described for boat-based recreational fishing (see above). In addition, to re-allocate the spatial distribution of the shore-based subsistence and

Table 3. Ratio of the spatial distribution of recreational fisheries landings for each Hellenic Statistical Authority of Greece (HELSTAT) subarea (Figure 1) based on Agricultural Statistics of Greece (ASG) records and field studies (Anagnopoulos *et al.* 1998).

HELSTAT subareas	ASG	Anagnopoulos <i>et al.</i> (1998)
	1975-1992	1995-1996
S3	0.028	0.013
S4	0.013	0.007
S5	0.251	0.053
S6	0.016	0.044
S7	0.020	0.016
S8	0.014	0.022
S9	0.075	0.055
S10	0.161	0.345
S11	0.025	0.058
S12	0.026	0.019
S13	0.047	0.133
S14	0.051	0.051
S15	0.075	0.041
S16	0.082	0.036
S17	0.076	0.055
S18	0.038	0.053

Table 4. Ratio of the species composition of recreational fisheries catches in Greek Seas based on the technical report by Anagnopoulos *et al.* (1998) during 1995-1996.

Species	Ratio
Fishes	
<i>Belone belone</i>	0.0004
Mugilidae	0.0016
<i>Trachurus trachurus</i>	0.0332
<i>Scomber japonicus</i>	0.0063
<i>Serranus</i> spp.	0.0629
<i>Spicara flexuosa</i>	0.0168
<i>Sparus aurata</i>	0.0047
<i>Pagellus erythrinus</i>	0.1219
<i>Pagrus pagrus</i>	0.0051
<i>Boops boops</i>	0.0516
<i>Oblada melanura</i>	0.0113
<i>Spicara maena</i>	0.0008
<i>Lithognathus mormyrus</i>	0.0426
<i>Mullus surmuletus</i>	0.0098
<i>Dentex macrophthalmus</i>	0.0477
<i>Sarpa salpa</i>	0.0063
<i>Trachurus mediterraneus</i>	0.0469
<i>Diplodus sargus sargus</i>	0.2302
<i>Epinephelus marginatus</i>	0.0016
<i>Diplodus annularis</i>	0.1622
<i>Spondyliosoma cantharus</i>	0.0191
Scorpaenidae	0.0461
<i>Dentex dentex</i>	0.0016
Other species	0.0672
Cephalopods	
<i>Octopus vulgaris</i>	0.0023

recreational catches for the three studied areas with the 16 HELSTAT subareas (Figure 2), we considered that Kavala Gulf is representative of the HELSTAT subareas S12 to S15, Pagasitikos Gulf of the HELSTAT subareas S10 to S11 and Patraikos Gulf of the HELSTAT subareas S³ to S9 and also for subareas S16 to S18, for which such data are not available. The taxonomic disaggregation of the shore-based subsistence and recreational catches was done by using the species composition in Table 5.

The shore-based subsistence and recreational catches per species for each HELSTAT subarea from 1950-2010 were estimated from the multiplication of the species ratio to total catches per subarea with the ratio of the number of fishers to the total human population per HELSTAT subarea during 1950-2010.

To split the catches between the subsistence and recreational components, we assumed that the percentage of shore-based recreational catches changed from 10% for 1950 to 90% in 2010. Then, we interpolated this ratio for the years during 1950-2010 using the exponential trend that describes the Greek Gross Domestic Product (GDP; data from World Bank) during the same period.

Thus, two time series of ratios were constructed describing the contribution of the shore-based recreational and subsistence catches during 1950-2010. These time series of ratios were multiplied with the above-estimated combined shore-based subsistence and recreational catches per species for each HELSTAT subarea during 1950-2010, in order to disaggregate the subsistence and shore-based recreational catches.

Discarded catches

Discards were estimated as a discard to catch ratio (D/C ratio) based on field studies in Greek waters since 1993 (Appendix 1). Discard ratios differed for each species, both within and among gears, according to: (a) species that were discarded due to their non-commercial value; (b) the fraction of the undersized individuals of the marketable species that were discarded according to European (ER 1967/2006) and national (P.D. 666/66) legislation; and (c) damaged individuals of the marketable species due to fishing operations (for trawlers: Machias *et al.* 2001; for small-scale vessels: Gonçalves *et al.* 2007; Tzanatos *et al.* 2007).

It should be mentioned that reconstruction of discards did not include taxa that always are discarded (i.e., those with D/C ratios equal to 1), which are mainly caught by trawlers (see Table 2 in Machias *et al.* 2001), because these species are not being recorded by HELSTAT. Thus, our discard estimates are likely conservative and clearly are minimal estimates.

Table 5. Species composition (%) of shore-based subsistence and recreational catches in Greek waters based on interviews in three coastal areas (see Methods).

Species	Pagasitikos	Patraikos	Kavala
<i>Auxis thazard</i>	0.60	-	-
<i>Belone belone</i>	0.62	-	-
<i>Boops boops</i>	0.64	0.38	-
<i>Dentex dentex</i>	0.44	-	1.56
<i>Dicentrarchus labrax</i>	7.78	6.22	11.15
<i>Diplodus annularis</i>	11.26	1.57	18.25
<i>Diplodus sargus sargus</i>	4.46	11.45	3.51
<i>Epinephelus aeneus</i>	0.10	-	-
<i>Epinephelus alexandrinus</i>	0.10	-	0.78
<i>Epinephelus marginatus</i>	0.10	-	-
<i>Euthynus alletteratus</i>	0.63	-	-
<i>Gobius</i> spp.	0.32	-	-
<i>Lithognathus mormyrus</i>	2.24	-	4.68
<i>Merluccius merluccius</i>	0.13	-	-
Mugilidae	18.32	24.54	19.50
<i>Mullus barbatus</i>	0.14	-	-
<i>Mullus surmuletus</i>	0.10	-	-
<i>Oblada melanura</i>	2.03	-	-
<i>Pagellus erythrinus</i>	3.08	0.36	-
<i>Polyprion americanus</i>	0.00	-	0.39
<i>Pomatomus saltatrix</i>	10.28	-	-
<i>Sarda sarda</i>	0.42	-	-
<i>Sarpa salpa</i>	0.77	-	-
<i>Sciaena umbra</i>	0.20	-	-
<i>Scomber japonicus</i>	2.45	-	8.97
<i>Serranus</i> spp.	0.07	-	-
<i>Seriola dumerili</i>	0.00	-	0.78
<i>Solea</i> spp.	0.00	0.63	-
<i>Sparus aurata</i>	15.30	50.46	12.87
<i>Sphyaena sphyraena</i>	0.21	-	-
<i>Spicara flexuosa</i>	2.91	-	-
<i>Spicara maena</i>	1.06	-	-
<i>Spicara smaris</i>	0.07	-	-
<i>Spondylisoma cantharus</i>	0.17	-	1.17
<i>Thunnus</i> spp.	0.14	-	-
<i>Trachurus mediterraneus</i>	2.09	2.53	7.80
<i>Umbrina cirrhosa</i>	0.07	-	-
<i>Osteichthyes</i>	6.38	1.86	8.58
<u>Cephalopods</u>			
Loliginidae, Ommastrepiidae	1.08	-	-
<i>Loligo vulgaris</i>	1.06	-	-
<i>Octopus vulgaris</i>	1.83	-	-
<i>Sepia officinalis</i>	0.35	-	-
<u>List of Osteichthyes species</u>			
<i>Caranx</i> sp.	0.71	-	-
<i>Coryphaena</i> spp.	0.47	-	-
<i>Dentex gibbosus</i>	0.10	-	0.78
<i>Diplodus vulgaris</i>	1.53	0.07	7.80
<i>Diplodus puntazzo</i>	0.00	1.79	-
Labridae	0.07	-	-
<i>Lichia amia</i>	0.34	-	-
<i>Pagellus acarne</i>	1.06	-	-
<i>Pagellus bogaraveo</i>	1.89	-	-
<i>Trachinus</i> spp.	0.21	-	-
Mean number of fishing days	191.00	193.30	180.00
kg-fisher⁻¹·day⁻¹	0.80	0.86	0.71

Greek overseas, distant-water fisheries

Historic description

Starting in 1952, Greek distant-water fleets began exploiting the Atlantic Ocean and the African Mediterranean coasts, and since 1965 it expanded into the Indian Ocean. Catch data are derived from: (a) the Directorate of Fisheries (formerly Ministry of Industry) through fisheries co-operations in collaboration with HELSTAT and the Agricultural Bank of Greece during 1952-1963 (Ananiadis and Chondronikolas 1970); and (b) HELSTAT during 1964-2010 (Table 1).

Reconstruction of distant-water catches

During 1952-1963, Greek official data for overseas landings refer to total landings for all species and areas combined (Ananiadis and Chondronikolas 1970). These landings were spatially allocated to Atlantic and North African waters using the mean proportion of overseas landings in Atlantic and North African waters as recorded by HELSTAT for the period 1965-1973 (Figure 3). Thereafter, landings were taxonomically disaggregated using the mean (1952-1963) landings per area (i.e., Atlantic and North African Mediterranean) reported by Ananiadis and Chondronikolas (1970) and shown in Table (6).

For 1964-2010, HELSTAT reports overseas landings data per species for two fishing areas; S¹ for Atlantic waters (and Indian Ocean) and S² for North African Mediterranean waters. For 1964-1981, HELSTAT overseas landings data are available for 23 taxa, while for the period after 1982, HELSTAT overseas landings data are available for 66 fish, cephalopod and crustacean taxa. To disaggregate the taxonomically aggregated landings for the period 1964-1981 to individual taxa as recorded for the period 1982-2010, the procedure used in Tsikliras *et al.* (2007) was adopted.

Reconstruction of Greek fisheries catches for 1950-1974

During 1950-1963, FAO reports Greek landings by taxon from all fisheries (i.e., marine, freshwater and lagoons) that are collected by the Greek Directorate of Fisheries (formerly Ministry of Industry). Since 1964, HELSTAT records and publishes the Greek landings from all motorized vessels including (between 1964-1969) or excluding (between 1970-1974) the small-scale vessels with engine power 19 HP. Moutopoulos and Stergiou (2012) present landings from motorized vessels for 1950-1974, without including the landings from non-motorized boats. Here, we incorporated these non-motorized boat landings for the period 1950-1974.

HELSTAT landings data are based on questionnaire surveys of a stratified sample of fishing vessels in each Greek subarea (Serbetis 1949), whereas ASG records fisheries landings during 1950-1974 based on surveys of fisher cooperatives, which were established by ASG for that reason (Serbetis 1949). ASG data usually refer to Greek fisheries as a whole (i.e., overseas, marine motorized vessels and non-motorized boats, lagoon and freshwater fisheries) (Ananiadis 1968) (Figure 4). Landings data from Greek marine fisheries are scanty during the 1950s and 1960s (Anon. 1977).

From ASG marine landings data that were available, the annual ratio of marine landings to total Greek landings was estimated (Figure 4), which was used to estimate the Greek marine landings during 1950-1974. The spatial and taxonomic disaggregation of reconstructed landings was based on Moutopoulos and Stergiou (2012).

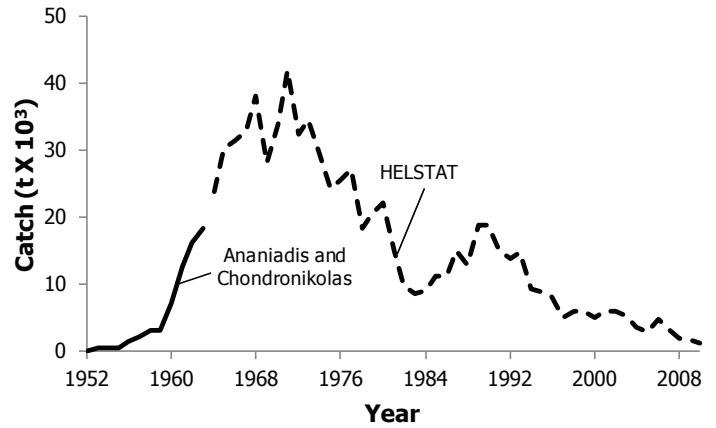


Figure 3. Total (all areas combined) overseas landings from data derived by different sources; Ananiadis and Chondronikolas (1972) and HELSTAT (1964-2010). Landings from the 1952-1964 period were disaggregated by area using the ratio of total landings in Atlantic waters to total overseas landings.

Table 6. Mean percentage composition of the species or group of species caught by overseas fishing vessels in Atlantic and North African waters during 1952-1963. Species listed in alphabetic order.

Atlantic Ocean		North African waters	
Species	%	Species	%
<u>Fishes</u>		<u>Fishes</u>	
<i>Pagellus erythrinus</i>	25.8	<i>Spicara flexuosa</i>	5.7
<i>Pagrus pagrus</i>	23.2	<i>Spicara maena</i>	13.7
<i>Spondyliosoma cantharus</i>	6.5	<i>Spicara smaris</i>	12.6
<i>Mustelus spp.</i>	3.7	<i>Pagellus erythrinus</i>	14.0
<i>Dentex macrophthalmus</i>	3.6	<i>Pagrus pagrus</i>	14.0
<i>Epinephelus marginatus</i>	2.7	<i>Mustelus spp.</i>	13.0
<i>Epinephelus alexandrinus</i>	4.8	<i>Solea spp.</i>	3.0
<i>Polyprion americanus</i>	0.8	Other taxa	24.0
<i>Solea spp</i>	2.1	-	-
<i>Trachurus mediterraneus</i>	1.2	-	-
<i>Trachurus trachurus</i>	0.2	-	-
Triglidae	1.1	-	-
<i>Diplodus sargus</i>	0.9	-	-
<i>Pomatomus saltatrix</i>	0.9	-	-
Other non recorded species	4.1	-	-
<u>Cephalopods</u>			
<i>Loligo vulgaris</i>	7.0	-	-
<i>Octopus vulgaris</i>	7.0	-	-
<i>Sepia officinalis</i>	4.2	-	-

Reconstruction of total Greek marine catches

The final reconstructed fisheries catches (i.e., reported landings, unreported catches and discards) by species (i.e., 75 species), subarea (i.e., 16 Greek subareas and 2 overseas subareas) and gear (i.e., trawls, purse-seines, beach-seines and other small-scale gears using motorized and non-motorized vessels) for Greek waters for 1950-2010, together with recreational, subsistence and overseas fisheries landings, were derived by summing each of the above components.

RESULTS

Catches within Greek waters

Boat-based recreational catches increased from just under 1,600 t·year⁻¹ in 1950 to slightly over 35,600 t·year⁻¹ in 1986 and then decreased to around 15,000 t·year⁻¹ by 2010 (Figure 5).

Total shore-based subsistence and shore-based recreational catches increased from over 1,800 t·year⁻¹ in 1950 to slightly over 2,800 t·year⁻¹ in 2010 (Figure 5).

Total discarded catches gradually increased from just under 13,000 t·year⁻¹ to a peak of just under 92,000 t·year⁻¹ in 1994, and then gradually declined to around 43,500 t·year⁻¹ by 2010 (Figure 6).

Greek total catches (including discards) are dominated by the small-scale, commercial (i.e., artisanal) fisheries, which accounted for 4.9 million t over the full time period considered here. This compares to the industrial sector with 3.8 million t and the recreational sector with nearly 987,000 t, while subsistence fishing accounted for just over 87,000 t (Figure 7a).

Total Greek catches (i.e., industrial, artisanal, recreational, and subsistence, plus discards) were here estimated at over 9.8 million t for 1950-2010, which is 57% higher than the 6.2 million t officially reported by Greece. Total catches in Greek waters increased from 64,800 t·year⁻¹ in 1950 to a peak of slightly over 311,000 t·year⁻¹ in 1994, before declining to just under 173,000 t·year⁻¹ by 2010 (Figure 7a).

The breakdown by taxonomic group revealed that catches composed of Sparidae (26.6%), Clupeidae (10.8%), Engraulidae (7.7%), Carangidae (7.1%), Scombridae (6.0%), Mullidae (4.4%), Merlucciidae (4.1%) and Mugilidae (3.4%) (Figure 7b). Invertebrates catches comprised 7.7% of the total reconstructed catches and were dominated by Cephalopods (73.4%).

Greek distant water catches

Greek overseas landings accounted for over 831,000 t, increasing from just over 150 t·year⁻¹ in 1952 to 42,300 t·year⁻¹ in 1971, before declining substantially to 1,300 t·year⁻¹ by 2010. With respect to the spatial location of fishing, catches derived from the Atlantic and Indian Ocean dominated, accounting for 96% (i.e., over 795,000 t) of total distant water catches, with the remaining 35,500 t having been caught in non-Greek Mediterranean waters.

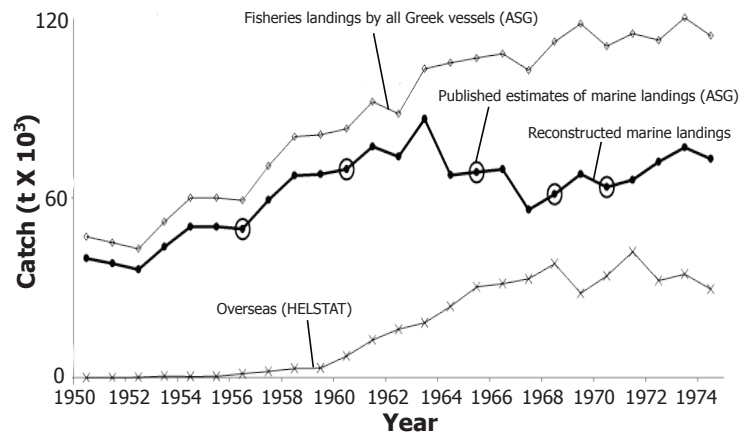


Figure 4. Annual total fisheries landings from Greek waters derived by different sources during 1950-1974. ASG, Agricultural Statistics of Greece and HELSAT, Hellenic Statistical Authority. Published estimates of marine landings (ASG) shown through circle dots represent 5 anchor points.

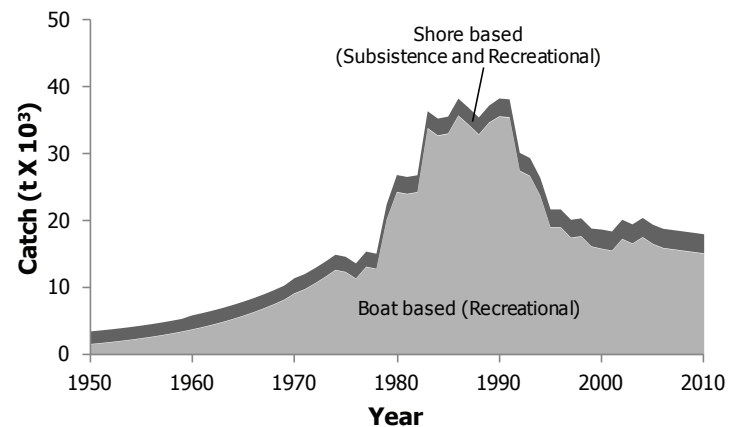


Figure 5. Greece's catches of boat based fisheries versus shore-based fisheries during the period 1950-2010.

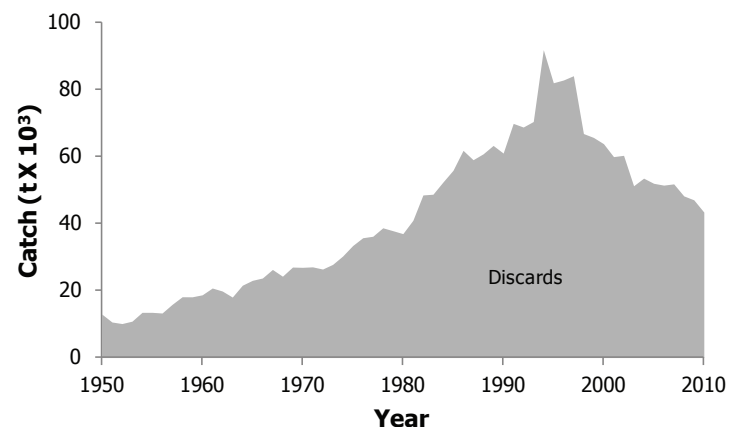


Figure 6. Total discards within Greece's EEZ, during the period 1950-2010.

Seven species contributed more than 50% of the overseas landings, both in Atlantic and North African Mediterranean waters (Tables 6, 7): *Pagrus pagrus* and *Pagellus erythrinus* dominated landings from Atlantic waters (13.9% and 12.0%, respectively), whereas *Mullus surmuletus* and *Spicara smaris* mainly contributed to the landings derived from North African Mediterranean waters (22.0% and 13.5%, respectively).

DISCUSSION

In the present study, we reconstructed Greek fisheries catches by gear and subarea from all Greek fisheries operating in Greek and overseas waters during 1950-2010. Thus, the final data series incorporates the marine fisheries catches from: (a) commercial motorized vessels, (b) commercial non-motorized vessels, (c) boat-based recreational fishing, (d) shore-based subsistence and recreational fishing, (e) discards by commercial fisheries, and (f) Greek distant-water fisheries. By inclusion of accurate estimates of IUU catches, such as the categories (c) to (e), leads to a more realistic evaluation of Greek fisheries resources.

The historic development of total marine catches during 1950-2010 parallels the pattern shown in Moutopoulos and Stergiou (2012) for the development of Greek commercial fisheries. In particular, during 1950-1994, a rapid development of Greek fisheries took place; from the growth phase (until 1969) towards the fully to over-exploited phase (up to 1994). In contrast, during 1995-2010, fisheries catches substantially declined to 43% of their maximum estimates in 1994.

The description of landings trends during the growth and fully to overexploited phases has been presented by Moutopoulos and Stergiou (2011, 2012) and has been attributed to: (a) the organization of the Greek fisheries administration since the end of WW II, (b) the establishment of fisheries and oceanographic research, and (c) the international (up to the mid-1960s) and European (since 1983) subsidization of the fishing sector. Since 1995, Greek fisheries have been faced with a general decline in landings because fisheries have become unsustainable, independently of gear type and subarea (Moutopoulos and Stergiou 2012).

Among the different fisheries components that are studied here, subsistence, recreational and overseas fisheries have never been examined for Greek waters before. Shore-based subsistence and recreational fisheries generally target the more highly prized species of Sparidae, a fact that is also common in the recreational fisheries of other Mediterranean countries (Turkey: Unal *et al.* 2010; Southern Portugal: Veiga *et al.* 2011). The trends of shore-based subsistence and recreational catches depict a gradual increase over time that follows the growth of the coastal human population.

On the other hand, the historical development of boat-based recreational fisheries showed that the large decrease of catches since the early 1990s was attributed to the first restriction on gear and catches established for the recreational fisheries since 1985 through national legislation (Presidential Decree, P.D. 373/1985). Before 1985, there were no limitations for recreational fisheries, which often operated in the same way as commercial small-scale fisheries (Anagnopoulos *et al.* 1998). Thus, since 1985 a large number of boat-based 'recreational' fishers applied for commercial licenses in order to maintain the advantage of using professional gears.

With respect to Greek distant-water fisheries, since its establishment in 1952,

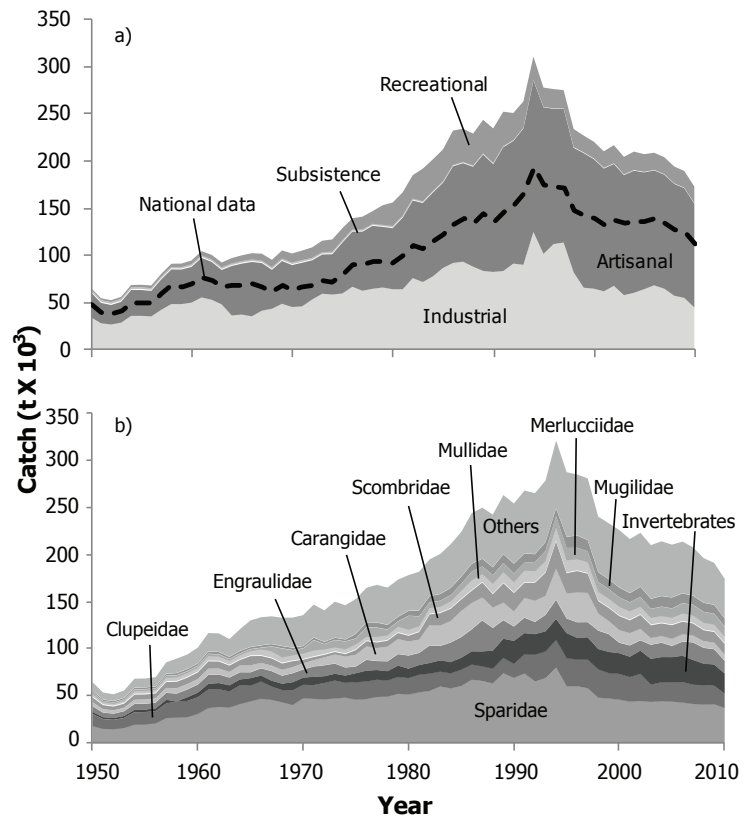


Figure 7. Reconstructed total catch of Greece, during the period 1950-2010 (a) by sector with reported data overlaid as line graph; (b) by taxonomic group, others represent 24 taxonomic groups.

Table 7. Species composition (%) per fishing area for the landings derived by Greek distant-water vessels, during 1964-2010. Species listed in terms of abundance.

Atlantic waters	%	North African Mediterranean waters	%
<u>Fishes</u>		<u>Fishes</u>	
<i>Pagrus pagrus</i>	13.9	<i>Mullus surmuletus</i>	22.0
<i>Pagellus erythrinus</i>	12.0	<i>Spicara smaris</i>	13.5
<i>Merluccius merluccius</i>	8.6	<i>Spicara maena</i>	13.2
<i>Mullus surmuletus</i>	5.3	<i>Pagellus erythrinus</i>	10.7
<u>Cephalopods</u>		<i>Spicara flexuosa</i>	6.1
<i>Sepia officinalis</i>	6.8	<i>Boops boops</i>	3.1
<i>Loligo</i> spp.	4.5	<i>Mullus barbatus</i>	2.3
<u>Crustaceans</u>			
Natantia	7.3		
Other non recorded species	21.2	Other non recorded species	8.4
Other recorded species	20.3	Other recorded species	20.8

distant-water fleets gradually expanded their operation from the North African Mediterranean waters to Atlantic and Indian Ocean waters since 1965, where distant vessels exploited the tropical waters along the coasts of Senegal, Nigeria and Persian Gulf mainly targeting shrimps. The spatial expansion of this fleet also led to an increase in the number of active fishing days (Ananiadis and Chondronikolas 1970).

The gradual decrease of overseas landings after 1973 is attributed to the global oil crisis occurring in 1973. The gradual increase of overseas landings during 1977-1989 is attributed to the fisheries agreement signed by the Greek and Libyan governments in 1977, which removed restrictions for Greek vessels fishing in Libyan waters (Ananiadis and Chondronikolas 1970; Anon. 1977).

Overall, the gradual decrease of overseas landings is attributed to: (a) the increasing restrictions of access to fishing grounds resulting from the declaration of EEZs by coastal African countries, (b) the lack of a fish processing industry in Greece (only 0.05% of the overseas landings were directed to the Greek processing industry), and (c) the lack of well-organized marketing options (Ananiadis and Chondronikolas 1970; Ananiadis 1984).

Finally, it is worth noting that the present reconstruction does not directly address or incorporate the long-term structural changes in fishing effort, both in terms of the number of vessels by gear type and the change in fishing intensity by gear type. This will be addressed in a future study. The advantages of the reconstructed fisheries catches presented in this study as opposed to those derived from national agencies, are: (a) the length of the time series (a continuous record from 1928 to 2010 of which herein we present only those for the years 1950-2010)¹, (b) the spatial coverage (16 fishing subareas of Greek waters), (c) homogeneity of the taxonomic composition of landings, and (d) separation of landings by fishing sector, subarea and fishing gear.²

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¹ Contact the senior author for pre-1950 data.

² Contact the senior author for gear-specific data not presented here.

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Appendix Table A1. Discard ratios for each studied species for Greek waters. For bottom trawl, 28D and 40D refer to the mesh-size of the cod-end net (stretched in mm).

Species	Area	Bottom trawl (28D)	Bottom trawl (40D)*	Beach seine	Purse-seine (1950-1999)	Purse-seine (2000-2010)	Surface longlines	Bottom longlines	Netters
Fishes	Greek waters	0.440	0.347	-	0.278	-	0.020	0.029	-
Cephalopods	Greek waters	0.210	0.137	0.291	0.278	-	0.500	0.029	0.150
Crustaceans	Greek waters	0.655	0.451	0.291	0.278	-	0.500	0.029	0.113
Fishes	Ionian Sea	-	-	0.231	-	0.022	-	-	0.113
	Aegean Sea	-	-	0.350	-	0.046	-	-	0.092
<i>Auxis thazard</i>	Ionian	-	-	-	-	-	-	-	0.080
<i>Boops boops</i>	Ionian	-	-	-	0.010	-	-	-	0.375
	Aegean Sea	-	-	-	0.280	-	-	-	-
<i>Centrophorus granulosus</i>	Aegean Sea	0.855	-	-	-	-	0.010	-	-
<i>Chelidonichthys lastoviza</i>	Cyclades	-	-	-	-	-	-	-	1.000
<i>Citharus linguatula</i>	Ionian	-	-	-	-	-	-	-	0.052
<i>Conger conger</i>	Ionian	-	-	-	-	-	-	0.110	0.626
<i>Dasyatis pastinaca</i>	Aegean Sea	0.194	-	-	-	-	-	-	1.000
<i>Dicentrarchus labrax</i>	Ionian	-	-	-	-	-	-	-	0.032
<i>Diplodus annularis</i>	Ionian	-	-	-	-	-	-	-	0.103
<i>Diplodus sargus</i>	Cyclades	-	-	-	-	-	-	-	0.117
<i>Diplodus vulgaris</i>	Cyclades	-	-	-	-	-	-	-	0.186
<i>Engraulis encrasicolus</i>	Greek waters	-	-	-	0.010	-	-	-	-
<i>Galeus</i> spp.	Greek waters	0.654	-	-	-	-	-	-	-
<i>Lophius piscatorius</i>	Greek waters	-	0.025	-	-	-	-	-	0.025
<i>Merluccius merluccius</i>	Greek waters	0.284	0.049	-	-	-	-	0.108	0.031
<i>Micromesistius poutassou</i>	Greek waters	-	0.042	-	-	-	-	-	0.202
<i>Mugilidae</i>	Ionian	-	-	-	-	-	-	-	0.075
<i>Mullus barbatus</i>	Greek waters	-	0.008	-	-	-	-	-	0.051
<i>Mullus surmuletus</i>	Cyclades	-	-	-	-	-	-	-	0.000
<i>Pagellus erythrinus</i>	Ionian	-	-	-	-	-	-	-	0.090
<i>Pagrus pagrus</i>	Cyclades	-	-	-	-	-	-	-	0.293
<i>Raja</i> spp.	Aegean Sea	0.880	-	-	-	-	0.010	-	0.561
<i>Sardina pilchardus</i>	Greek waters	-	-	-	0.010	-	-	-	-
	Ionian	-	-	-	0.280	-	-	-	0.758
<i>Sardinella aurita</i>	Aegean Sea	-	-	-	0.130	-	-	-	-
<i>Sarpa salpa</i>	Ionian	-	-	-	-	-	-	-	0.428
<i>Scomber japonicus</i>	Aegean Sea	-	-	-	0.010	-	-	-	-
<i>Scorpaena</i> spp.	Ionian	-	-	-	-	-	-	-	0.139
<i>Scyliorhinus</i> spp., <i>Mustellus</i> spp.	Greek waters	0.892	0.082	-	-	-	-	-	-
<i>Spicara flexuosa</i>	Ionian	-	-	-	-	-	-	-	0.839
<i>Spicara maena</i>	Ionian	-	-	-	-	-	-	-	0.839
<i>Spicara smaris</i>	Ionian	-	-	-	0.020	-	-	-	-
<i>Squalus</i> spp.	Greek waters	0.564	-	-	-	-	0.010	-	-
<i>Trachinus draco</i>	Ionian	-	-	-	-	-	-	0.500	1.000
<i>Trachurus mediterraneus</i>	Greek waters	0.791	0.099	-	-	-	-	-	0.022
<i>Trachurus trachurus</i>	Greek waters	0.791	0.099	-	-	-	-	-	0.500
<i>Triglidae</i>	Ionian	-	0.045	-	-	-	-	-	0.303
<i>Torpedo</i> spp.	Greek waters	1.000	-	-	-	-	-	0.359	1.000
<i>Uranoscopus scaber</i>	Ionian	-	-	-	-	-	-	-	0.120
<i>Xiphias gladius</i>	Greek waters	-	-	-	-	-	0.010	-	-

*Since 2003, the mesh size of the cod-end net for bottom trawl has been increased according to European Regulation (ER 2550/2000) and National Law (N B 20/16-1-2001).

Appendix Table A2. Resident population by prefecture during 1950-2010 according to the census by the Hellenic Statistical Authority (HELSTAT).

Prefectures	HELSTAT	1951	1961	1971	1981	1991	2001	2011
Achaia	S5	228,871	240,354	240,854	275,193	300,078	318,928	322,789
Argolida	S8	85,389	90,145	88,698	93,020	97,636	102,392	105,770
Arkadia	S8	151,361	135,042	111,263	107,932	105,309	91,326	102,035
Arta	S4	72,717	84,285	79,700	80,044	78,719	73,620	78,134
Chalkidiki	S13	75,735	79,263	73,390	79,036	92,117	98,810	104,894
Chania	S18	126,524	131,061	119,797	125,856	133,774	148,450	150,387
Chios	S15	66,823	62,223	53,948	49,865	52,184	53,106	53,408
Dodekanissos	S16	121,480	123,021	121,017	145,071	163,476	188,506	190,071
Etolia & Akarnania	S5	220,138	237,738	228,989	219,764	228,180	219,092	224,429
Evia	S10	82,271	86,289	86,292	94,205	104,204	103,652	107,568
Evia	S12	82,271	86,289	86,292	94,205	104,204	103,652	107,568
Evros	S14	141,340	157,760	138,988	148,486	143,752	149,283	149,354
Fokida	S9	51,472	47,842	41,361	44,222	44,183	37,866	48,284
Fthiotida	S10	148,322	161,436	155,574	161,995	171,274	169,542	178,771
Ilia	S6	188,274	187,713	164,061	160,305	179,429	183,521	193,288
Iraklio	S18	189,637	208,374	209,670	243,622	264,906	291,225	292,489
Kavala	S14	136,337	140,751	121,593	135,218	135,937	141,499	144,850
Kefallinia	S5	47,369	45,033	35,952	31,297	32,474	37,756	39,488
Kerkyra	S3	105,414	101,770	92,933	99,477	107,592	111,081	111,975
Korinthia	S9	113,358	112,505	113,115	123,042	141,823	144,527	154,624
Kyklades	S17	125,959	99,959	86,337	88,458	94,005	109,956	112,615
Lakonia	S7	130,898	118,661	95,844	93,218	95,698	92,811	99,637
Larissa	S13	208,120	231,976	233,159	254,295	270,612	282,156	279,305
Lassithi	S18	73,784	72,880	66,226	70,053	71,279	75,736	76,319
Lefkada	S4	37,752	30,261	25,371	21,863	21,863	21,888	22,506
Lesvos	S15	154,795	140,251	114,802	104,620	105,082	108,288	109,118
Magnissia	S11	153,808	162,285	161,392	182,222	198,434	205,005	206,995
Messinia	S6	227,871	211,970	173,077	159,818	166,964	166,566	176,876
Pieria	S13	86,161	98,284	92,354	106,859	116,763	126,412	129,846
Preveza	S4	56,779	60,868	55,262	55,915	58,628	58,144	59,356
Rethymno	S18	72,179	69,943	60,949	62,634	70,095	78,957	81,936
Rodopi	S14	105,723	109,201	107,677	107,957	103,190	111,237	110,828
Samos	S15	59,709	52,022	41,709	40,519	41,965	43,841	43,595
Thessaloniki	S13	459,956	546,286	711,990	871,580	946,864	1,084,001	1,057,825
Thesprotia	S3	47,299	52,125	40,684	41,278	44,188	43,601	46,091
Viotia	S9	106,838	107,775	107,459	117,175	134,108	123,913	131,085
Xanthi	S14	89,891	89,594	82,917	88,777	91,063	102,959	101,856
Zakynthos	S5	38,062	35,509	30,187	30,014	32,557	38,883	39,015
Greater Athens	S10	1,556,029	2,113,185	2,853,509	3,369,424	3,523,407	3,894,573	3,761,810
Total	-	6,226,716	6,921,929	7,504,392	8,378,534	8,868,016	9,536,761	9,506,790

Appendix Table A3. National landings vs. reconstructed total catch (in tonnes), and catch by sector with discards shown separately for Greece, 1950-2010.

Year	National	Reconstructed total catch	Industrial	Artisanal	Subsistence	Recreational	Discard
1950	48,424	64,800	31,000	17,400	1,690	1,760	13,000
1951	39,620	53,800	25,400	14,200	1,680	1,910	10,600
1952	37,859	51,800	24,300	13,600	1,670	2,070	10,200
1953	40,500	55,300	26,000	14,500	1,660	2,240	10,900
1954	50,355	68,000	32,300	18,100	1,660	2,430	13,500
1955	50,355	68,200	32,300	18,100	1,650	2,640	13,500
1956	49,600	67,400	31,800	17,800	1,640	2,870	13,300
1957	59,251	79,900	38,000	21,300	1,630	3,110	15,900
1958	67,392	90,600	43,200	24,200	1,620	3,380	18,200
1959	67,309	90,700	43,100	24,200	1,610	3,670	18,100
1960	69,500	94,000	44,500	25,000	1,780	4,020	18,700
1961	77,036	103,900	49,400	27,700	1,770	4,360	20,800
1962	73,687	100,100	47,200	26,500	1,750	4,740	19,900
1963	66,949	91,900	42,900	24,000	1,740	5,150	18,100
1964	67,622	96,600	33,000	34,600	1,730	5,590	21,600
1965	68,650	99,500	33,100	35,600	1,720	6,080	23,100
1966	69,748	101,800	31,800	37,900	1,700	6,610	23,800
1967	66,033	101,200	32,800	33,300	1,690	7,180	26,300
1968	60,950	94,700	33,800	27,200	1,670	7,810	24,300
1969	67,507	104,700	37,700	29,800	1,660	8,490	27,000
1970	63,304	101,500	34,100	29,200	1,780	9,470	27,000
1971	65,691	104,600	35,300	30,400	1,760	10,080	27,100
1972	68,875	108,000	41,600	27,300	1,740	10,960	26,400
1973	73,612	115,100	46,300	27,300	1,720	11,920	27,800
1974	71,459	116,500	43,500	27,900	1,700	12,970	30,300
1975	80,561	128,400	45,000	35,500	1,680	12,690	33,500
1976	89,834	139,000	51,200	38,600	1,660	11,740	35,800
1977	89,371	140,700	47,900	41,400	1,640	13,490	36,200
1978	92,953	146,500	48,800	44,100	1,620	13,200	38,800
1979	92,893	152,800	50,400	42,500	1,590	20,430	37,900
1980	92,418	155,800	49,700	42,800	1,750	24,580	37,000
1981	99,531	166,600	49,300	50,200	1,720	24,320	41,000
1982	110,087	185,000	55,700	54,400	1,690	24,600	48,600
1983	107,402	191,900	52,000	55,400	1,660	33,990	48,800
1984	114,696	201,700	56,100	58,600	1,630	32,950	52,500
1985	121,465	212,300	62,000	59,400	1,600	33,270	55,900
1986	132,969	232,400	65,700	67,300	1,570	35,930	61,900
1987	139,099	234,400	70,500	68,600	1,530	34,630	59,100
1988	133,579	229,200	64,000	69,600	1,490	33,250	60,900
1989	143,965	243,800	62,800	81,100	1,460	35,010	63,400
1990	136,102	234,700	61,000	75,100	1,500	36,020	61,100
1991	145,129	252,500	58,200	87,000	1,460	35,940	70,000
1992	152,630	251,100	66,400	86,300	1,410	28,150	68,900
1993	164,118	263,400	68,300	95,800	1,370	27,450	70,500
1994	193,281	311,200	86,700	106,600	1,320	24,590	92,000
1995	174,733	278,100	71,200	103,600	1,270	20,030	82,100
1996	172,374	276,600	77,000	95,400	1,220	20,080	82,900
1997	171,470	275,500	76,800	94,700	1,170	18,620	84,200
1998	147,189	234,100	59,300	87,900	1,110	18,880	66,900
1999	142,741	227,000	47,400	95,300	1,050	17,450	65,800
2000	138,317	220,600	46,900	91,400	1,070	17,290	63,900
2001	132,177	210,300	45,300	86,800	1,000	17,080	60,000
2002	136,615	216,800	50,500	86,100	930	18,860	60,400
2003	134,009	204,500	49,300	84,700	860	18,260	51,300
2004	136,371	210,000	50,400	86,000	790	19,270	53,600
2005	136,102	207,200	53,700	82,400	710	18,350	52,100
2006	138,773	208,800	57,700	81,100	630	17,840	51,500
2007	133,964	204,100	53,600	80,400	550	17,730	51,900
2008	127,720	194,100	48,800	78,900	460	17,610	48,300
2009	124,348	189,400	47,000	77,400	380	17,500	47,100
2010	111,649	172,800	38,500	73,100	280	17,390	43,500

Appendix Table A4. Reconstructed total catch (in tonnes) by major families for Greece, 1950–2010. ‘Others’ contain 24 additional taxonomic categories.

Year	Sparidae	Clupeidae	Invertebrates	Engraulidae	Carangidae	Scombridae	Mullidae	Merlucciidae	Mugilidae	Others
1950	19,000	12,500	2,440	6,060	3,990	5,060	3,980	1,530	1,590	8,660
1951	16,100	10,200	2,000	4,960	3,310	4,150	3,260	1,250	1,370	7,220
1952	15,700	9,800	1,940	4,740	3,190	3,970	3,120	1,200	1,330	6,980
1953	17,000	10,500	2,150	5,070	3,410	4,240	3,340	1,280	1,400	7,550
1954	20,500	13,000	2,620	6,300	4,190	5,260	4,150	1,590	1,640	9,190
1955	20,600	13,000	2,620	6,300	4,210	5,260	4,150	1,590	1,640	9,230
1956	21,800	12,800	2,960	6,210	4,200	5,180	4,100	1,570	1,620	9,580
1957	27,300	15,300	4,000	7,420	5,020	6,180	4,920	1,870	1,860	11,880
1958	27,900	17,100	-	8,310	5,440	6,730	5,120	1,970	1,970	15,130
1959	28,200	17,100	4,040	8,300	5,460	6,720	5,120	1,960	1,970	15,190
1960	31,700	17,600	4,850	8,570	5,710	6,950	5,320	2,030	2,050	16,570
1961	37,800	19,500	6,180	9,500	6,380	7,700	5,930	2,250	2,230	19,270
1962	39,000	18,700	6,610	9,080	6,200	7,360	5,680	2,140	2,150	19,530
1963	38,300	17,000	6,650	8,250	5,750	6,700	5,200	1,940	1,990	18,670
1964	41,900	20,000	6,170	7,670	7,000	5,780	5,480	1,600	2,380	22,870
1965	44,700	16,500	8,180	6,250	7,190	9,730	5,630	1,980	1,910	27,980
1966	47,500	18,200	6,570	7,630	5,640	7,300	7,190	1,660	2,220	29,610
1967	46,300	14,100	6,330	10,200	5,740	7,500	7,790	5,010	2,270	29,190
1968	43,800	12,900	6,880	8,480	6,030	6,690	6,860	9,300	2,180	29,880
1969	41,000	15,400	8,780	9,570	6,300	6,180	6,600	5,300	2,380	31,630
1970	48,000	14,300	7,720	8,700	6,410	3,760	6,940	5,220	2,110	32,660
1971	47,400	14,600	8,880	10,880	6,530	3,230	7,340	10,870	2,370	34,750
1972	46,900	17,300	7,260	11,590	8,240	2,650	6,150	5,440	2,020	33,210
1973	47,700	19,100	7,270	10,810	9,450	2,600	5,230	7,710	2,100	37,970
1974	48,700	15,700	7,790	8,600	11,470	2,490	5,560	8,110	1,810	36,020
1975	46,400	18,600	9,660	7,200	12,190	5,010	6,230	6,140	4,670	36,750
1976	47,200	18,500	11,670	11,400	14,050	5,500	4,970	10,190	4,800	36,340
1977	49,400	18,300	10,290	9,590	13,630	5,890	6,240	9,680	5,070	39,780
1978	49,600	17,200	9,990	10,480	15,400	6,210	6,030	5,970	4,770	39,230
1979	52,600	17,900	12,170	12,160	15,880	6,260	7,010	5,560	4,610	39,200
1980	51,900	17,400	10,050	13,970	14,760	6,010	6,700	14,640	5,010	37,570
1981	54,200	18,600	10,500	12,820	13,980	7,900	6,470	10,420	5,960	40,840
1982	55,600	18,400	11,400	18,490	21,600	11,240	6,960	6,060	6,210	38,730
1983	60,300	15,800	12,070	15,340	21,460	13,100	7,100	6,150	6,950	42,180
1984	58,300	16,000	12,070	20,630	22,750	12,910	8,000	6,530	7,470	46,120
1985	60,700	17,400	12,790	21,840	27,670	12,040	9,450	7,250	7,270	47,290
1986	67,300	16,300	14,120	23,300	27,980	12,770	11,230	9,170	8,150	53,420
1987	66,000	15,700	15,850	32,700	24,370	15,770	9,210	7,980	8,010	53,870
1988	63,500	15,800	19,250	23,900	21,620	14,090	11,020	9,300	8,030	55,710
1989	74,100	16,700	20,240	19,620	18,710	20,340	11,980	9,710	9,100	62,370
1990	69,100	15,200	24,300	15,260	15,920	19,470	11,680	9,120	10,260	63,510
1991	73,800	20,800	22,330	16,360	20,830	16,090	13,060	8,340	9,630	66,390
1992	65,500	28,500	21,780	12,900	22,680	18,880	12,330	9,680	8,190	64,450
1993	69,000	28,500	21,290	17,440	20,190	24,390	12,390	10,820	9,260	64,970
1994	79,800	29,700	22,270	20,260	32,980	28,820	14,280	12,480	8,380	71,590
1995	60,400	29,800	26,550	15,530	26,520	21,340	13,690	13,200	11,640	68,290
1996	60,500	28,400	22,930	16,600	31,610	22,550	12,770	12,000	12,870	64,410
1997	58,500	30,400	23,560	16,040	31,000	20,230	12,300	11,520	11,780	65,170
1998	48,600	29,900	21,590	19,530	18,210	13,000	10,070	10,160	10,330	58,630
1999	47,800	26,800	22,470	18,720	13,890	13,790	10,120	10,020	10,280	59,040
2000	46,500	27,300	21,970	11,110	13,340	14,700	10,170	9,770	10,260	60,650
2001	44,600	25,800	21,580	12,020	12,920	13,530	9,760	9,410	9,620	57,010
2002	45,200	28,600	24,560	10,950	12,100	14,710	9,080	10,040	10,580	56,980
2003	44,200	18,200	27,400	14,870	7,050	13,540	8,180	9,290	10,490	56,640
2004	45,000	20,000	26,580	15,240	6,990	13,340	8,070	9,810	11,010	57,790
2005	44,500	20,600	26,470	11,930	7,410	14,440	8,040	9,880	11,370	55,690
2006	43,500	21,700	27,820	14,950	7,780	13,260	8,880	10,840	10,270	54,510
2007	42,000	20,200	26,330	18,540	7,210	12,750	8,760	11,090	9,470	51,000
2008	41,400	20,500	22,690	16,820	7,030	11,470	8,220	11,400	9,450	47,050
2009	41,800	19,500	22,580	16,160	6,990	11,080	8,180	11,270	9,280	44,320
2010	38,000	14,900	21,360	13,430	6,480	11,350	8,000	10,500	8,480	41,560